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Contagion Effects in the Aftermath of *Lehman*’s Collapse: Measuring the Collateral Damage

Abstract: The spectacular failure of the 150-year old investment bank *Lehman Brothers* on September 15th, 2008 was a major turning point in the global financial crisis that broke out in the summer 2007. Through the use of stock market data and Credit Default Swap (CDS) spreads, this paper examines the investors’ reaction to *Lehman*’s collapse in an attempt to identify a contagion effect on the surviving financial institutions. The empirical analysis indicates that (*i*) the collateral damages were limited to the largest financial firms; (*ii*) the most affected institutions were the surviving “non-bank” financial services firms (mortgage and specialty finance, investment services, and diversified financial services firms); (*iii*) the negative effect was correlated with financial conditions of the surviving institutions. We also detect significant abnormal jumps in the CDS spreads after Lehman’s failure that we interpret as evidence of sudden upward revisions in the market assessment of future default probabilities for the surviving financial firms.

Keywords: systemic risk; financial crisis; bank failures; contagion; bailout; regulation; Credit Default Swap

JEL Classification Codes: G21; G28

1. Introduction

The spectacular failure of the 150-year old investment bank Lehman Brothers has been perceived by many as a major turning point in the global financial crisis that broke out in the Summer 2007. The specter of systemic risk raised widespread fears of a full-scale collapse of the US financial sector due to financial contagion and concerns about significant disturbances outside the US, in international financial markets. According to the bankruptcy petition #08-13555, filed on Monday, September 15th, 2008, Lehman's total assets of $639 billion made it the largest failure in US history, about six times larger than the largest previous failure (see Table 1). The complexity of the case relies in part on the billions of dollars in claims from creditors and counterparties located in various corners of the financial system. According to Lehman's bankruptcy administrator, the mass of creditors filed more than 60,000 claims against the failed investment bank before the deadline imposed by the court, September 22nd, 2009.

{Table 1}

Financial media extensively discussed the case during the week that followed the bankruptcy announcement date, often using a broad array of metaphors and bombastic terms: "*a tsunami sweeping the financial industry*" and "*sending tremors worldwide*"; "*a financial Armageddon*" having *"a massive effect on hundreds of other businesses, from real estate to restaurants*"; "*a perfect storm*" sparking "*a chain reaction that sent credit markets into disarray*"; "*the biggest economic firestorm since the Great Depression*" that "*presented too great a threat to the financial system and the economy*" and "*set off a cascade of events around the globe*"; "*a devastating blow to the global financial world.*"[1] However, as noted by

[1] The representative sample of terms quoted here was extracted from articles published by leading financial newspapers in the US (*Wall Street Journal*, *New York Times*, *Washington Post*, *New York Daily News* etc.) or

Kaufman (2000), it is not uncommon that the adverse implications of large financial firms' failures are exaggerated in the press, the resulting "tales of horror" being often taken as "facts." He attributes this propensity of the financial media to exaggerate to the veil of ignorance that deter the general public to understand very well the functioning and complexity of the financial system. As a consequence, the financial sector is somewhat steeped in mysticism and exposed to fictitious accounts of its operations, particularly the adverse effects of large failures, widespread financial problems and generalized breakdowns.

Among academics and researchers, there was considerable debate about the nature, triggering events, and extent of systemic risk during the recent global financial crisis. This debate reflects undoubtedly more general difficulties to define properly the concept of systemic risk and the absence of a broad consensus in the financial literature. Kaufman (1994, 2000), De Bandt and Hartmann (2002), and Kaufman and Scott (2003) propose excellent surveys on contagion and systemic risk in banking and financial systems. Taylor (2009a) provides an updated and interesting discussion of systemic risk in the context of the current financial crisis and highlights the urgent need for an *operational* definition of the concept. According to Kaufman and Scott (2003), systemic risk -- referring to the risk or probability of widespread breakdowns in the entire financial system and evidenced by an extreme clustering of failures -- is one of the most feared events by banking regulators and supervisors. De Bandt and Hartmann (2002) make a useful distinction between *narrowly*- vs. *broadly*-defined "systemic events." The first notion refers to occurrences where the failure of a financial institution or simply the release of adverse information about its conditions propagates through a "domino effect" to other financial institutions and markets. The latter definition include both systemic events in the narrow sense *and* simultaneous adverse effects on a large number of financial

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reports issued by world-class publishers of business and financial information like *Dow Jones*, *Reuters*, and *Bloomberg* on days following September 15th, 2008.

institutions caused by a widespread big or systematic (macro)shock. The various definitions place at the core of the concept of systemic risk the notion of *contagion*, which describes the propagation mechanisms of the effects of shocks from one or more financial firms to others. The phenomenon of contagion is widely perceived as being more dangerous in the financial sector than in other industries because (*i*) it occurs generally faster; (*ii*) it spreads more broadly within the industry; (*iii*) it results in a greater number of failures and larger losses to creditors; (*iv*) it can affects otherwise solvent financial institutions (see Kaufman, 1994). For all these reasons, it is widely considered that systemic risk is the strongest argument justifying the intervention of public authorities in the financial sector.

Since the beginning of the global financial crisis in August 2007, many large institutions at the core of the financial systems in developed and developing countries have been bailed out by the public authorities in the name of contagion and systemic risk. In the US, for instance, financial institutions like *Bear Sterns*, *Fannie Mae*, *Freddy Mac*, *American Insurance Group*, and *Citigroup* were all considered systemically important or "too big (or interconnected) to fail" (TBTF) and the government decided to protect them from failure by injecting huge amounts of taxpayers' money. However, in the particular case of Lehman, the outcome was drastically different: instead of conceiving an emergency rescue plan, the government allowed the nation's fourth-largest investment bank to collapse when no viable private-sector solution could be found.[2] The government justified its no-bail-out decision on the grounds that, unlike in the case of *Bear Sterns*, market participants have had sufficient time to prepare themselves to absorb the collateral damages eventually caused by the imminent collapse of Lehman. Moreover, in contrast to *Bear Sterns*, Lehman had direct access to short-term facilities from

[2] The failure to find a white knight ready to assume Lehman's liabilities is clearly due to the government decision to refuse any financial facilities to potential interested parties, as it has been the case for instance in March 2008 when JP Morgan Chase acquired the troubled investment bank Bear Sterns.

the Federal Reserve.[3] Top government officials also pointed out that they viewed *Fannie Mae* and *Freddie Mac* as far more systemically important than *Lehman* because the two mortgage giants own or guarantee about half of home loans originated in the US.[4]

In contrast to the government officials' view, for many observers the failure of Lehman was an event triggering systemic risk and panic in financial markets. For instance, Acharya, Philippon, Richardson, and Roubini (2009) mention the Lehman failure as a clear example of systemic risk that materialized during the global financial crisis of 2007-2009. They note, with the benefits of hindsight, that Lehman contained "*considerable systemic risk*" and led to "*the near collapse of the financial system*." Portes (2008) takes a more sanguine view suggesting that the government decision not to rescue Lehman was a policy error that exacerbated the adverse effects of the financial crisis. The critics generally share the view that the systemic crisis that has emerged in the aftermath of Lehman's failure could have been mitigated if the government had intervened.

Other influential economists embraced the opposite view, arguing that it was not Lehman's failure but the uncertainty surrounding the ill-conceived 2½-page draft of legislation regarding the *Troubled Asset Relief Program* (TARP) released several days afterward that effectively trigger the global panic of the fall 2008. Taylor (2009b) and Cochrane and

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[3] Immediately after the near-failure of *Bear Stern*, on March 17th, 2008, the Federal Reserve created an exceptional lending facility (the *Primary Dealer Credit Facility*, PDCF) that enabled investment banks and other primary dealers for the first time to access liquidity in the overnight loans market for short-term needs. The PDCF was intended to mitigate adverse effects from future failures of investment banks (see Adrian, Burke, and McAndrews, 2009, for further details).

[4] In his press conference on Monday, September 15th 2008, the US Secretary of the Treasury Henry M. Paulson Jr. clearly stated: "*The actions with respect to Fannie Mae and Freddie Mac are so extraordinarily important, not only to our capital markets, but to making sure we have plenty of finance in housing, because that is going to be the key to turning the corner here.*" (*Dow Jones Newswire*, September 15th, 2008)

Zingales (2009) are representative of this view. They use event studies based on graphical analysis to show that basic risk indicators of stress in the financial sector, such as the Libor-OIS and CDS spreads, reacted apathetically to Lehman's collapse. By contrast, the same stress indicators exhibited very strong and negative responses just after the Federal Reserve Board Chairman Ben Bernanke and Treasury Secretary Henry Paulson testified at the Senate Banking Committee about the TARP, several days later, on September 23rd and 24th, 2008. In the same vein, Rogoff (2008) contends that in the case of Lehman the government applied the right medicine at the right moment and approves its decision to deny taxpayers money to rescue the troubled investment bank.

The main objective of the present study is to answer two research questions related to the systemic nature of the collapse of Lehman Brothers viewed as a turning point in the current financial crisis. First, through the use of stock market and Credit Default Swap (CDS) data, we examine the investors' reaction to Lehman's failure in an attempt to identify an eventual contagion effect on the surviving financial institutions.[5] Our second research question is whether the contagion effect, if it was statistically significant, affected the other surviving financial firms *indiscriminately*, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to Lehman. The answers to these questions have broad policy implications and help shed light on an unsolved debate about the nature of the events triggering systemic risk during the recent global financial crisis.

[5] As noted by Zingales (2008), Lehman's collapse also had a dramatic impact on money market funds industry. The Reserve Primary Fund, a large US money market mutual fund, decided on September 16th to freeze redemptions because of its large exposure to Lehman debt. As the net asset value of its shares fell below $1, the fund "broke the buck" and contributed to the panic of October 2008. The idea to investigate the effects of Lehman's collapse on the mutual funds industry is left for future work.

Our paper is related to a recent contribution by Fernando, May, and Megginson (2012) investigating the impact of the Lehman collapse on the industrial firms that received underwriting, advisory, analyst, and market-making services from Lehman. They conduct an event study analysis and show that Lehman's equity underwriting clients experienced an abnormal return of around –5%, on average, on several days surrounding the bankruptcy announcement. The negative wealth effects were especially severe for companies that had stronger security underwriting relationships with Lehman or were smaller, younger, and more financially constrained. Fernando et al. (2012) conclude their article by suggesting an interesting interpretation of their findings from a TBTF perspective: the negative effects of a large (investment) bank failure on its clients – industrial firms may offer an alternative rationale for the government intervention besides the classical systemic risk (financial contagion) argument. As we focus on the effects of Lehman's failure on a different set of firms (*viz*. the surviving *financial* firms), our findings complement the results reported in Fernando et al. (2012) and significantly extend the TBTF / systemic risk interpretation of the event of interest.[6]

The rest of the paper is organized as follows. Section 2 presents the research methodology and Section 3 describes the data sources used in our study, as well as the sampling procedure. The main results concerning the market's reaction to the Lehman's failure announcement are presented in Section 4. Finally, Section 5 concludes and discusses some policy implications.

[6] Our paper is also related to the earlier literature investigating the effects of a large financial institution's failure on the performance of the surviving financial firms (see e.g. Wall and Peterson, 1990; Aharony and Swary, 1996; Peavy and Hempel, 1998) and the pricing of risk in the financial markets after a TBTF episode or a systemic event (see e.g. Cornell and Shapiro, 1986; O'Hara and Shaw, 1991; Brewer et al., 2003; Pop and Pop, 2009).

2. Methodology

To determine whether Lehman's collapse had a significant impact on the performance of the surviving financial firms, we begin by investigating the reaction of the stock market to the failure event. For that purpose, we use variations of the conventional event study methodology. This section briefly describes our choices for estimating abnormal stock returns and compares the benefits and drawbacks of each method within the context of Lehman's failure.

The first modeling choice has been commonly employed in the financial literature to examine the reaction of the stock market to a significant event, such as a regulatory change, affecting *all* firms in the same industry (see e.g. Binder, 1985; Schipper and Thompson, 1983; Cornett and Tehranian, 1990; Karafiath et al., 1991; Brewer et al., 2003). Since all firms in our sample come from the financial services industry and share common event dates, we have to avoid the well-known misspecification problems in the conventional event study methodology due to extreme clustering. Indeed, failure to take into account the cross-sectional dependence might induce a systematic underestimation of the standard deviation of the mean abnormal returns, implying that the standardized test statistic is no longer applicable.[7]

According to the first method, what we call the "collateral damage" of *Lehman*'s failure is quantified within a multivariate regression framework that takes the following form:

$$\tilde{R}_{it} = \alpha_{i0} + \beta_{im} R_{mt} + \sum_{\tau=0}^{1} \beta_{i\tau} \mathcal{D}_{\tau t} + \tilde{\varepsilon}_{it} \qquad [1]$$

where

[7] According to Schwert (1981), the cross-sectional dependence in returns around the underlying event date is mainly due to the fact that firms in the same industry tend to react in the same way to the event of interest. Traditional event study methodology assumes independent abnormal returns. An alternative solution would have been to adopt a portfolio approach as in Wall and Peterson (1990).

$\tilde{R}_{it}$ is the stock return of financial institution i ($i = 1, 2, \dots, N$) on day t ($t = 1, 2, \dots, T$);

R_{mt} is the corresponding broad market index (S&P 500) return for day t;

α_{i0} is the intercept coefficient, an event-independent constant term for financial firm i;

β_{im} is the systematic risk coefficient or the sensitivity of the firm i's rate of return to changes in the market's rate of return;

$\mathcal{D}_{\tau t}$ is a binary variable that equals 1 if the event of interest occurred on day τ or during the window τ ($\tau \in [0, +1]$) and zero otherwise;

$\beta_{i\tau}$ is the event coefficient or the sensitivity of bank i's rate of return to the event of interest;

$\tilde{\varepsilon}_{it}$ is a random error which is assumed to be independent of the market return, serially independent and normally distributed.

The equation from which the various models are developed can equally be written as

$$\begin{bmatrix} \widetilde{\mathbf{R}}_1 \\ \widetilde{\mathbf{R}}_2 \\ \vdots \\ \widetilde{\mathbf{R}}_N \end{bmatrix} = \begin{bmatrix} \boldsymbol{X} & \mathbf{0} & \cdots & \mathbf{0} \\ \mathbf{0} & \boldsymbol{X} & \cdots & \mathbf{0} \\ \vdots & \vdots & \ddots & \vdots \\ \mathbf{0} & \mathbf{0} & \cdots & \boldsymbol{X} \end{bmatrix} \boldsymbol{\beta} + \begin{bmatrix} \tilde{\boldsymbol{\epsilon}}_1 \\ \tilde{\boldsymbol{\epsilon}}_2 \\ \vdots \\ \tilde{\boldsymbol{\epsilon}}_N \end{bmatrix} \qquad [2]$$

or more simply

$$\widetilde{\mathbf{R}} = \mathbf{X}\boldsymbol{\beta} + \tilde{\boldsymbol{\epsilon}} \qquad [3]$$

The regression model assumes that the coefficient vector $\boldsymbol{\beta}_{NJ\times 1}$ is the same for all panels and the matrix of independent variables $\boldsymbol{X}_{NT\times NJ}$ is the same for each equation in the system. We also assume that the error terms are i.i.d. within each equation (firm), in addition to having different scale variance, i.e. we allow the disturbance variance to differ *across* equations. Finally, following the discussion at the beginning of this section, we assume that the contemporaneous covariance of the error terms can differ from zero, $Cov[\tilde{\varepsilon}_{it}, \tilde{\varepsilon}_{jt}] \neq 0$ if $i \neq j$, although the noncontemporaneous covariances are all zero, $Cov[\tilde{\varepsilon}_{it}, \tilde{\varepsilon}_{js}] = 0$ if $t \neq s$. These various assumptions imply that the variance matrix of the disturbance terms can be written as

$$\mathbf{\Omega} = \mathbb{E}[\tilde{\boldsymbol{\epsilon}}\tilde{\boldsymbol{\epsilon}}'] = \mathbf{\Sigma}_{N\times N} \otimes \mathbf{I}_{T\times T} = \begin{bmatrix} \sigma_1^2\mathbf{I} & \sigma_{12}\mathbf{I} & \cdots & \sigma_{1N}\mathbf{I} \\ \sigma_{21}\mathbf{I} & \sigma_2^2\mathbf{I} & \cdots & \sigma_{2N}\mathbf{I} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma_{N1}\mathbf{I} & \sigma_{N2}\mathbf{I} & \cdots & \sigma_N^2\mathbf{I} \end{bmatrix} \qquad [4]$$

where $\mathbf{\Sigma}$ is the covariance matrix of $(\tilde{\varepsilon}_{1t}, \tilde{\varepsilon}_{2t}, \ldots, \tilde{\varepsilon}_{Nt})$, $\mathbf{I}$ is the identity matrix and $\otimes$ is the Kronecker product.

Equation [3] can be viewed as a linear system of equations in which a separate equation is estimated for each financial institution i included in the final sample. The regression parameters are estimated based on Zellner's (1962) seemingly unrelated regression (SUR) model using the generalized least squares (GLS) estimation method. The values of the parameters $\beta_{i\tau}$ in equation [1] capture the individual banks' estimated "abnormal" returns associated with the failure announcement on day τ or during the window $\tau \in [0, +1]$. They are estimated using daily data before and after the event date over an estimation period sufficiently long to obtain meaningful statistical inferences. Precisely, we use stock market data for 235 days prior to the event date (t = –235 to t = –1) to 18 days after the event date (t = +18), i.e. from October 9th, 2007 to October 9th, 2008.

While the SUR methodology takes into account the cross-sectional dependence in returns and results in more efficient estimates than ordinary least squares (OLS) estimation, it has its own drawbacks. Particularly, estimating abnormal returns with SUR requires that the time dimension (i.e. the number of days in the estimation period) be *larger* than the number of firms for the large-sample approximations to be reliable. In addition, for computational reasons, the number of observations per firm should exceed the total number of firms, to render the variance matrix of the disturbance terms, $\mathbf{\Omega}$, of full rank and invertible. Consequently, when applying SUR the number of firms included in the estimation sample is limited to 250; for that reason, when estimating SUR regressions we selected the 250 *largest* US financial institutions among the 382 firms included in our final sample.

To capture the behavior of the entire universe of financial firms included in our final sample, we privilege in this paper the estimation of the abnormal returns for firm security *i* on event day *t*, AR_{it}, as the difference between actual returns R_{it} and the returns predicted by the market model, $\mathrm{E}[R_{it}|\Phi_t]$, where $\Phi_t = \{R_{mt}\}$ and R_{mt} is the stock market return (S&P500) for day *t*:

$$AR_{it} = R_{it} - \mathrm{E}[R_{it}|\Phi_t] \qquad [5]$$

where $\mathrm{E}[R_{it}|\Phi_t] = \hat{\alpha}_i + \hat{\beta}_i R_{mt}$. The market model parameters, $\hat{\alpha}_i$ and $\hat{\beta}_i$, are estimated by regressing the daily (log-differenced) stock return for the relevant financial firm security, R_{it}, upon the corresponding broad market return, R_{mt}, using ordinary least squares. The market model is estimated over a 250-day "estimation window" beginning *t* = –260 through *t* = –11. We define the "event day" as *t* = 0 and a time frame of 10 days on either side of the announcement date as the "event window." Lehman Brothers filed for Chapter 11 bankruptcy protection on September 15th, 2008, which is defined as the "event day" *t* = 0.

To avoid misspecification problems due to extreme clustering, we use the test statistic recommended by Brown and Warner (1985) and also used by O'Hara and Shaw (1990), which is free of cross-sectional dependence in the security-specific excess returns. For any given day *t*, the test statistic is defined as:

$$\overline{AR}_t / \hat{s}(\overline{AR}_t) \qquad [6]$$

where $\overline{AR}_t = \left(1/N_j\right)\sum_{i=1}^{N_j} AR_{it}$ is the average daily abnormal return across sample banks, N_j is the number of firms in the sample *j*, $\hat{s}(\overline{AR}_t) = \left[\sum_{t=-260}^{-11}\left(\overline{AR}_t - \overline{\overline{AR}}\right)^2/(250-1)\right]^{1/2}$ is an estimator of the standard deviation on day *t* based on the residual returns in the estimation period, and $\overline{\overline{AR}} = (1/250)\sum_{t=-260}^{-11}\overline{AR}_t$. It is worth noting that by using a time-series of average abnormal returns, the test statistic as defined *supra* is free of any potential bias induced by the cross-correlation of security returns in the event period.

Since the market-model parameters were estimated over the estimation period, the abnormal returns are in fact prediction errors. Consequently, the standard deviation estimator used in the definition of the test statistic is appropriately adjusted in order not to overstate the significance levels. The correction factor is defined as follows:

$$k_t = \left\{1 + (1/250)\left[1 + (R_{mt} - \bar{R}_m)^2/\sigma_{R_m}^2\right]\right\} \qquad [7]$$

where $\bar{R}_m$ and $\sigma_{R_m}^2$ are the mean and variance of the market return in the estimation window. The standard error of the forecast is simply calculated by multiplying the estimator of the standard deviation on day *t* by the correction factor.

The test statistic described above can be easily adjusted to investigate the significance of the average abnormal returns aggregated over various event windows. For any interval $[\tau_1; \tau_2]$ in the $[-10;\ +10]$ event window, the test statistic is defined as:

$$\overline{CAR}_{[\tau_1;\tau_2]}/\left[\sum_{t=\tau_1}^{\tau_2} \hat{s}^2(\overline{AR}_t)\right]^{1/2} \qquad [8]$$

where $\overline{CAR}_{[\tau_1;\tau_2]} = \sum_{t=\tau_1}^{\tau_2} \overline{AR}_t$ is the cumulative average abnormal return. As in the previous case, we use the correction factor k_t to capture the idea that the market-model parameters are subject to estimation errors.

Finally, as a robustness check we also consider an alternative procedure for the estimation of excess returns, which is less sensitive to the reliance on past returns. Precisely, for each security the expected return is defined to be equal to the return of the market portfolio. Thus, abnormal returns AR_{it} are defined as the difference between the daily returns of security *i* on day t, R_{it}, and the daily returns of the market portfolio on day t, R_{mt} (the market portfolio returns are proxied as previously by the total returns of the S&P 500 Index):

$$AR_{it} = R_{it} - R_{mt} \quad [9]$$

Results from simulations with daily data confirm that the market-adjusted returns procedure does a reasonably good job in identifying event-related effects and has high power even in cases involving event-date clustering (see Brown and Warner, 1985). The significance tests are adjusted using standard procedures described in Brown and Warner (1985).

In what follows, all the results discussed at length in Section 4 are based on the market-model abnormal returns. For the sake of comparison, we also mention the estimations obtained using the first method, i.e. the SUR framework, particularly when the results obtained by applying alternative modeling choices improve the overall interpretation.

3. Data description

To document empirically the potential contagion effects related to Lehman's failure on the other financial firms, we collect detailed pricing-relevant information from the US stock market. This section briefly describes the sampling procedures and data sources used in our empirical analysis.

Our dataset is built using financial information reported in *Bloomberg* database. We collect daily stock price data from January 1st, 2008, to December 31st, 2008, for all *large* publicly traded *financial* firms. By "large" we mean every institution that reported total assets higher than US$ 1 billion in the last audited financial report before the event date. By "financial" we mean every institution operating in the same industry as Lehman's (Finance-Investment, SIC code 6211) or primarily in other fields of finance (banking; equity investment instruments;

asset management; consumer finance; investment services, mortgage finance, specialty finance…). For stocks that were simultaneously listed on more than one exchange, pricing information is collected from the most actively traded exchange or the primary exchange for the stock. *Bloomberg* reports daily opening, closing, high/low, bid/ask prices, as well as historical series of trading volumes. The price data are adjusted to reflect major capital events that include scrip issues/rights offerings, open offers, stock splits and consolidations, reductions of capital, scrip (stock) dividends etc.[8] Our initial sample includes 413 financial institutions. However, our final sample satisfies the following additional selection criteria:

- using *Dow Jones Factiva* database, we imposed that major capital events such as stock splits, stock dividends, and other significant news did not occur on the event day;
- we dropped all banks that had "thinly" traded stocks during the sample period, defined as those for which daily stock price data were missing for more than six consecutive trading days;
- finally, for a financial firm to be included in our sample, it must have no missing stock return data on the event day.

These selection criteria reduced our final sample to 382 financial institutions: 305 "banks" (of which 60 S&Ls) and 77 "non-bank" financial services firms (including Lehman). To explain better the stock market reaction to the failure event, we also collected financial information from *Bloomberg* for each firm included in our final sample. Credit rating information for a sub-sample of rated financial institutions was collected from *Reuters* and *Bloomberg*, while

[8] The general principle upon which *Bloomberg* makes all adjustments is to render past data fully comparable with current data.

the list of the largest physical exposures to Lehman and its subsidiaries are obtained from *Epiq Systems*, the corporate restructuring company that administrate Lehman's bankruptcy.[9]

4. Empirical results

4.1. Evidence of contagion effects in stock market prices

Did the failure announcement have a significant impact on the surviving financial firm stock returns? Did the shareholder reactions to Lehman's collapse vary across individual financial firms? To answer these questions, Table 2 reports the *F*-statistic for the following two hypotheses:

- H_0^1: $\beta_1 = \ldots = \beta_N = 0$, i.e. the individual abnormal returns are jointly equal to zero for each day in the event window [-2; +2] and each sub-sample of financial firms;
- H_0^2: $\beta_1 = \ldots = \beta_N$, i.e. the individual abnormal returns are jointly equal to each other.

The abnormal returns for a five-day period surrounding the failure announcement date (day 0 or September 15th, 2008) are derived from the SUR framework described in the methodology section. The full sample of US financial firms was partitioned into various sub-samples with respect to size (*Panel A*) and type of activity (*Panel B*). Inspecting Table 2, in the vast majority of cases, both hypotheses are soundly rejected: the failure announcement triggered a significant reaction in the stock market and shareholder responses varied substantially across individual financial firms.

{Table 2}

[9] We are grateful to Tina Wheelon (*Epiq System*) for help with data.

The refine this preliminary finding, we also report in Tables 3 and 4 the results of the event study analysis described in Section 2, separately for the global sample ($N = 382$), as well as for various subsamples defined with respect to size (small, medium, and large) or type of activity (banking firms; non-bank FIs; commercial banks; S&Ls; diversified financial services firms; investment services firms; mortgage and specialty finance firms; and consumer finance firms). On average, the abnormal returns calculated over the event window [–2 ; +2] are not statistically significant for the entire sample of FIs. The negative average abnormal return of –0.50% reported on day $t = 0$ (September 15th, 2008) is due to the inclusion of Lehman in the global sample. When we exclude the failed investment bank from the sample, the average abnormal return of the surviving FIs on day $t = 0$ is positive (+0.24%), albeit not statistically distinguishable from zero.[10]

{Table 3}

One may be tempted to infer that the bankruptcy filing by Lehman on Monday, September 15th, did not trigger any significant reaction in the stock market. However, aggregating all data into a single global sample could mask significant heterogeneity among listed FIs. Scrutinizing Table 3, we can observe that the smallest FIs experience a significantly *positive* abnormal return of +3.03% according to the parametric *t*-test (p-value < 0.05) on the event day.[11] This result suggests that at least for the smallest FIs, the stock market reaction was driven by factors other than "contagion." To strengthen our argument, it is worth noting that the vast majority (almost 90%) of FIs included in the "small-size" subsample are small

[10] This result is confirmed when we employ alternative modeling choices for estimating abnormal returns, based on the SUR methodology or the market-adjusted procedure (*omitted output*).

[11] When the "small size" sample is defined with respect to the 1st quartile of the total assets (TA) variable, we find that the smallest FIs (\$1,000 mil. < TA < \$1,600 mil.) experience a significantly positive abnormal return of +3.65% (p-value < 0.01) on the event day.

commercial banks and S&Ls, without any significant exposure to Lehman. The "medium-size" FIs are not affected on average by the event, while the Top 20 "surviving" FIs show a negative abnormal return of –8.57%, significant at the 1% level and robust to the exclusion of Lehman from the "big-size" subsample (see Table 3).

To refine the interpretation of the results obtained for the largest FIs and reduce the arbitrariness behind the definition of the "big size" sample, we implement the following iterative procedure. First, we classify the entire population of financial firms according to the size of their balance-sheets as reported in the interim financial statements released at the end of June 2008. Second, we conduct iteratively the significance tests described in Section 2 for various portfolios including the k largest FIs, where k goes successively from 20 to 382 firms. The iterative procedure stops when the test indicates for the first time a switch from *significant* to *non-significant* abnormal returns on the event day 0 at the conventional statistical levels (1%, 5%, and 10%, respectively). Finally, we retain the cut-off value of k^*, as well as the corresponding test statistics and associated p-values.

The iterative procedure described above helps shed light on a highly relevant public policy issue: *how many of the largest US financial firms, taken together as a portfolio, show a significant negative abnormal return in the aftermath of Lehman's collapse?* We find that the *Top 35 / 49 / 69 largest* FIs exhibit, on average, a *significant* abnormal return of –6.32% (p-value < 0.01) / –4.28% (p-value < 0.05) / –3.50% (p-value < 0.10) on day 0.[12] These findings imply that the collateral damages associated with Lehman's failure were indeed limited to the *largest* financial firms. The result is reinforced by the analysis of the cumulative abnormal returns (CAR). The CARs computed over whatever window are not significantly different

[12] Notice that, in contrast to the "small-size" sample, among the largest FIs composing the various "big-size" samples (Top 35 / 49 / 69 biggest FIs) there are many "non-bank" diversified financial services firms.

from zero neither for the full sample nor for the "medium-size" sample. Yet, the largest FIs show a significant *negative* CAR over various short windows surrounding the event date (see Table 3).[13]

After providing evidence that at least the largest US financial firms were hit by the Lehman failure, we turn now to the question whether the contagion effect was firm- or industry-specific. We have already mentioned in the introduction the distinction between the two types of failure contagion and noticed its relevance from a regulatory perspective. To test the hypothesis that the most affected financial firms are those having common characteristics with Lehman (i.e. operating in the same market or product area), we partitioned the full sample into eight subsamples according to the *Industry Classification Benchmark* (ICB) and *Bloomberg Industry Group* classifications: (*i*) banks and savings and loans (N = 305); (*ii*) commercial banks (N = 249); (*iii*) savings and loans (N = 60); (*iv*) mortgage and specialty finance (N = 18); (*v*) "non-bank" financial institutions (N = 77); (*vi*) diversified financial services firms (N = 54); (*vii*) investment services firms (N = 18); and (*viii*) consumer finance (N = 14). It is worth noting that according to these classifications, Lehman belongs to three

[13] We selected relatively short windows surrounding the event date because outside these short windows there were many significant events that may have affected the perception of Lehman's failure in the stock market. Particularly, on Tuesday, September 16th (day +1), the US Federal Reserve agrees to lend the American International Group (AIG) $85 billion in return for a 79.9% equity stake. Consequently, the CAR over the window [0; +1] should be interpreted as the *net* effect of two *opposite* regulatory policies: a *laissez-faire* approach (Lehman) and a bailout decision (AIG). On Wednesday, September 17th (day +2), the *Securities and Exchange Commission* restricted short selling in an attempt to decelerate the rapid fall of the largest firms' share value; an emergency ban on shorting FIs' stocks was pronounced one day later, on September 18th (day +3). On September 19th (day +4), the US Treasury announced its decision to guarantee money market mutual funds up to an amount of $50 billion to ensure their viability. The proposed $700 billion bailout package to rescue the US financial system was debated by the Congress on September 23–24 (days +6 to +7).

subsamples, namely "non-bank FIs" (*v*), "diversified financial services" (*vi*), and "investment services" (*vii*). The results reported in Table 4 lend support to the thesis that the collateral damage was firm-specific rather than industry-wide-specific. The highest and most significant *negative* abnormal returns are observed for the "surviving" financial firms providing mortgages, mortgage insurance, and other related services (–7.41%, significant at the 5% level) or operating in the same subsectors as Lehman: diversified financial services (–4.58%, *p*-value < 0.01); non-bank financial activities (–4.06%, *p*-value < 0.05); and investment services (–3.94%, *p*-value < 0.05). Among the firms operating in the banking sector (commercial banks and S&Ls), only the largest ones show significant negative abnormal returns (–5.14, significant at the 5% level).

{Table 4}

Overall, the preliminary findings discussed in this section indicates that the collateral damages associated to Lehman's collapse were limited to (*i*) the largest financial institutions (presumably the most exposed to the failure of the investment bank); (*ii*) the financial services firms operating in the same product area as the failed investment bank (non-bank activities, diversified financial services, and investment services); and (*iii*) firms providing mortgages, mortgage insurance, and other related services (i.e. operating in perhaps the most shaky sector after the summer 2007 and at the core of the current financial crisis). In the next section, we attempt to refine these findings by investigating more deeply the link between individual abnormal returns and various proxies for the FIs' risk profile.

4.2. Firm-specific vs. industry-wide collateral damages

To gain further insights into the results reported in the previous section, we examine in this section the economic determinants of the stock market reaction to the Lehman failure announcement. In this respect, we focus our analysis on a broad set of financial variables capturing three main dimensions of financial firms' performance, namely, risk profile, leverage, and profitability. All balance-sheet variables are measured by using accounting data reported in the interim financial statements disclosed by each firm in our sample at the end of June 2008.

The *risk profile* is proxied by the ratio of loan loss reserves to total loans, the loan loss provisions divided by the total loans, and the ratio of non-performing assets as a fraction of total assets. Higher values of these ratios indicate a deteriorated credit risk profile. Alternatively, as a broad market measure of the risk profile and financial conditions, we also use the credit ratings assigned by the two main rating agencies (*Moody's* and *S&P*) during the week preceding the Lehman failure announcement. These ratings represent an appreciation of the capacity of a FI to honor its senior unsecured long term financial commitments, denominated in local/foreign currency. The two agencies use similar scales and criteria, and assign comparable ratings. The credit ratings are converted to cardinal value according to the following scale: AAA/Aaa = 1, AA+/Aa1 = 2, AA/Aa2=3 etc., and then averaged across the two rating agencies. Hence, a lower cardinal value corresponds to a higher credit quality. Finally, an interesting risk proxy to be considered in our analysis is based on the physical exposure to Lehman.[14] The "largest exposure" dummy takes the value of 1 if the firm is on the *Epiq System* list of the largest reported claims and 0 otherwise. We conjecture that creditors having a significant physical exposure to Lehman should experience more adverse

[14] We considered the total amount of exposure, including different kinds of claims: loans, letters of credit, derivative and swap contracts, commercial papers obligations, bonds etc. The mass of Lehman's creditors filed more than 60,000 claims against the failed investment bank before the deadline imposed by the bankruptcy court, September 22nd, 2009. Note however that some of the claims are duplicates, i.e. claims filed for the same amount against several different Lehman units. According to Lehman claim administrator *Epiq Systems*, the duplicate or erroneous claims have been corrected.

valuation effects. It is worth noting that the physical exposures to Lehman were disclosed progressively, in most cases *after* the end of our short event window. Consequently, we suppose implicitly that information on exposures is already distilled in stock market prices during the several days surrounding the bankruptcy announcement date. Finally, an alternative risk proxy we use is the market measure of the probability of failure, computed as the ratio of the variance of equity returns over the 250-day estimation window divided by one plus the average equity return over the same window, squared (see Blair and Heggestad, 1978; Koehn and Santomero, 1980; and Appendix 1, for additional insights).

The degree of operating *leverage* is measured by the total debt / total assets ratio, the common equity / total asset ratio, and a bank-specific measure of the capital adequacy, the risk-based capital ratio. To distinguish between the impact of potential solvency problems and liquidity shortages, we also considered two additional gearing ratios that take into account the debt maturity structure: the ratio of long-term debt to total assets and short-term borrowings divided by the total liabilities and equity. We expect that FIs whose financing model is similar to Lehman, i.e. relying on rolling-over substantial amounts of short-term debt on a long-term basis, would be more affected by the failure.

Finally, the *profitability* dimension is proxied by conventional ratios: the return on equity (ROE), return on assets (ROA), and the net income to total assets ratio. We also considered an efficiency ratio computed as the cost to income ratio, expressed in percentages. Our conjecture is that FIs in better shape than their peers may have an improved shock-absorbing capacity and would be less affected by the Lehman failure.

Besides the size and industry classification, we ask the question whether there is any other significant difference between the four sub-samples of financial firms (small- *vs*. big-size; banks vs. non-banks FIs) that could explain the reaction of the stock market to the failure announcement. To answer this question, Table 5 summarizes the results of bivariate comparisons of the above mentioned risk, leverage, and profitability variables. Specifically, we compare the distribution of each performance variable in the four sub-samples of FIs by performing standard mean tests and two non-parametric tests: a chi-square two-sample test on the equality of medians and a Wilcoxon-Mann-Whitney test for the hypothesis that two independent samples are from populations with the same distribution.

{Table 5}

As far as the risk profile is concerned, it is apparent that the credit quality is significantly more deteriorated in the big-size (TA > Q3) and non-banks sub-samples. Note however, that the number of "non-bank" financial services firms reporting bank-specific variables, such as loan loss reserves and provisions, is quite low, rendering the cross-sector comparisons of these bank-specific variables less informative. As revealed by the data, the largest FIs and the non-bank financial firms are also more leveraged on average than their smaller peers and competitors operating in the banking sector. As before, the number of "non-bank" financial services firms reporting bank-specific capital adequacy measures like the risk-based capital ratio is quite low (12 against 288 banks), yielding to little informative comparisons in this particular case. Finally, the bivariate analysis of the various profitability measures does not allow us to infer clear conclusions, except that the larger FIs are somewhat more efficient than their smallest competitors.

We also report in Table 5 descriptive statistics for other control variables: firm size (total assets and total market value, expressed in million US dollars), price-to-book ratio, the fraction of the core banking activities (net loans to total assets ratio), and the extent to which the asset portfolio contains large amounts of market securities (the ratio of market securities to total assets). By design, the total assets and market values are significantly higher in the big-size sample ($170-180 billion against $45-46 billion). Moreover, the "non-bank" FIs are significantly larger than their "bank" peers ($92-93 billion against $33-34 billion). Not surprisingly, the fraction of net loans is higher for small FIs, given the composition of the two subsamples defined with respect to size,[15] and for firms operating in the banking sector. At the other extreme, the largest FIs and "non-bank" financial firms invest a higher fraction of their asset portfolios in marketable securities.

To determine whether the observed contagious effects were discriminating rather than undifferentiated, we report in Table 6 the pairwise correlation coefficients between standardized abnormal returns on day $t = 0$ (SAR0) and standardized cumulative abnormal returns over the window [0; +1] (SCAR[0; +1]), on the one side, and a group of factors that could explain the market's reaction to the Lehman failure. The correlation coefficients are computed for the global sample, as well as for the two sub-samples defined with respect to the industry classification: banks *vs*. non-banks. Both measures of abnormal returns are *negatively* correlated with *all* the risk measures and *positively* correlated with the profitability variables, especially for the FIs included in the "banks" sub-sample. That is, the more deteriorated the banking performance, the more negative and stronger the reaction of stock market prices to the bankruptcy announcement. We also find strong correlations between the degree of operating leverage and abnormal returns: the higher the leverage, the more negative the reaction of the stock market, irrespective of the (sub)sample used in the analysis.

{Table 6}

As previously anticipated, the two proxies for firm size and the "non-banks" dummy are strongly and negatively correlated with both measures of abnormal returns. This result is fully

[15] Indeed, the small-size sub-sample contains mostly commercial banks and S&Ls, while the big-size sub-sample includes a high number of investment services firms.

consistent with the preliminary findings discussed in the preceding section. Interestingly, the fraction of total assets invested in marketable securities is positively correlated with abnormal returns in the "banks" sample and negatively correlated in the "non-bank" sample. This means that for banks the portfolio of marketable securities is viewed as a liquidity cushion, while in the case of non-bank FIs, the marketable securities are perceived as a significant source of concern and uncertainty.

Overall, the results presented in this section lend empirical support to the thesis that the observed contagious effects in the aftermath of Lehman's collapse were consistent with a discriminating pricing and the information-based contagion effect hypothesis. Put differently, the contagion was firm-specific and discriminating rather than industry-wide or undifferentiated: the most affected financial firms were those having common characteristics with Lehman, i.e. operating in the same market, subsector or product area. Even more importantly, the individual abnormal stock returns are found to be strongly correlated with financial firms' fundamentals (risk profile, leverage, and profitability).

4.3. Abnormal jumps in CDS prices

To detect significant abnormal jumps in the pricing of risk in the credit derivatives market, we employ two straightforward statistical procedures: (*i*) a classical mean test and (*ii*) a constant mean model. In the first case, our conjecture is that the mean of changes in CDS spreads should be *positive* in the aftermath of Lehman's collapse, indicating a sudden *upward* revision in the market assessment of future default probabilities for the surviving financial firms. In the second case, the test consists of comparing the spread levels before and after the event date in order to detect a material break (or "jump") in CDS pricing.

For our mean test (i), we calculate the average spread changes for each day of the combined period (estimation and event windows) and then we sum over several days in the event window to obtain a measure of the cumulative average CDS spread change. The statistical significance of these measures can be judged by estimating the standard deviation of CDS spread changes over the estimation period.

Following the previous literature (see e.g. Hull *et al*., 2004; Norden and Weber, 2004), we control for market-wide systematic factors by computing CDS spread changes that are adjusted by changes of a CDS index:[16]

$$\delta s_{i,t} \equiv \left(CDS_{i,t} - CDS_{i,t-1}\right) - \left(I_t - I_{t-1}\right) \quad [10]$$

where $CDS_{i,t}$ is the CDS spread level, expressed in basis points, for the financial obligor i on a given day t and I_t is the CDS index level on day t.

The constant mean model (ii) is similar to the constant mean return model used in stock market event studies. The CDS spread is modeled in this case as

$$CDS_{i,t} = \mu_i + \xi_{i,t} \quad [11]$$

[16] The CDS index's source data as well as all the CDS composite spreads used in our analysis comes from *Thomson Reuters*. Based on the most liquid (i.e. 5-year) CDS contracts, the CDS index is equally weighted and reflect an average mid-spread calculation of the index's constituents. *Thomson Reuters* proprietary indices are rebalanced every six months to better reflect liquidity in the CDS market. Note that as broad indices for the CDS market (e.g. TracX, CDX, iTraxx, S&P/ISDA CDS Indices) have only recently been launched, Hull *et al*. (2004) and Norden and Weber (2004) among others, compute "rating-adjusted CDS spreads" by subtracting an index of spreads for a given rating from each CDS spread with the same rating. Specifically, daily CDS spread index level is computed by those authors as the equally-weighted cross-sectional mean of all CDS spreads for a certain broad rating class (AAA and AA, A, and BBB) in their samples. In this paper, we don't use rating-adjusted spreads because our CDS dataset contains a relatively small number of reference entities (18 banks and 67 non-bank FIs) and broad market CDS indices exist and are actively traded in 2008.

where μ_i is the mean of the CDS spread and $\xi_{i,t}$ the time period t disturbance term for financial obligor i with an expectation $\mathrm{E}[\xi_{i,t}] = 0$ and variance $\mathrm{Var}[\xi_{i,t}] = \sigma^2_{\xi_i}$. For each day of the event window, the abnormal CDS spread is estimated as

$$\hat{\xi}_{i,t} = CDS_{i,t} - \hat{\mu}_i \qquad [12]$$

where $\hat{\mu}_i$ designates the sample mean of the CDS spread over the estimation period. The cumulative abnormal CDS spread for event windows composed of days τ_1 through τ_2 is naturally defined as

$$CAS_{i,[\tau_1;\tau_2]} = \sum_{t=\tau_1}^{\tau_2} \hat{\xi}_{i,t} \qquad [13]$$

The test statistics used to investigate whether the event of interest has a significant impact on CDS pricing are constructed in a similar way as those commonly used in stock market event studies.

Figure 1a illustrates, in some basic way, Taylor's (2009b) and Cochrane and Zingales's (2009) idea that risk indicators of stress in the financial sector, such as the Libor-OIS spread and 1-year CDS spreads for Citigroup Inc., reacted much more strongly after the TARP testimony on September 23–24, 2008 than in the aftermath of Lehman's collapse.[17] However, if we focus on 5-year Citi-CDS quotes (Figure 1b), as this is the benchmark maturity in the CDS market, or longer maturity contracts (e.g. 10-year CDS as in Figure 1c), the reaction to

[17] In their WSJ article, published on September 15th, 2009, Cochrane and Zingales (2009) don't mention the tenor of the CDS contract for Citigroup used to draw their chart suggestively titled "*When concern turned to panic*." By comparing Citi-CDS spreads of different maturities reported by various data providers (*MarkIT*, *Credit Market Analysis*, *Bloomberg* and *Thomson Reuters*), we infer that the CDS depicted in Cochrane and Zingales's (2009) chart is the 1-year contract.

Lehman's failure appears of the same order of magnitude, if not larger, than the perceived impact of the TARP testimony.

{Figure 1ab&c}

To further investigate the effects of Lehman's collapse in the credit derivatives market, we collect Thomson Reuters CDS data over the period from January 1st, 2008, through December 31st, 2008, for *all* US reference entities belonging to the financial sector. We remove from our initial sample Lehman Brothers Holdings Inc. in order not to overstate the results, as well as those reference entities for which no CDS prices were available on the event date or CDS spread changes were zero over the 5-day event window [–2; +2]. Our final CDS sample includes 85 obligors (18 banks and 67 non-bank FIs).

{Table 7}

We present in Table 7 the average changes in the adjusted CDS spreads (expressed in basis points) on various periods surrounding the event date, separately for the 1-year CDS contracts (Panel A) and 5-year CDS contracts (Panel B).[18] For the sake of comparison, we also report in the same table the results obtained when the statistical tests are conducted on days surrounding Ben Bernanke's and Henry Paulson's TARP speeches before the Senate Banking Committee on September 23rd and 24th, 2008 ("*TARP testimony*", day 0 and +1 respectively).

On average, the adjusted CDS change is significant and positive on September 15th for the reference entities included in the whole sample: +60.50 bps ($p < 0.01$) and +87.58 bps ($p < 0.01$), depending on the maturity (one and five years, respectively). If we follow previous empirical studies on CDS pricing and focus our analysis on the 5-year CDSs (Panel B), which

[18] To save space, we do not report the average changes in the adjusted CDS spreads for the 10-year contracts as they are similar with those reported in Table 7 (Panel B).

are the most popular contracts among market participants and, hence, the most liquid ones, we observe a stronger reaction for non-bank FIs (+91.64 bps) compared with banks (+72.24 bps). Moreover, the cumulative change over the various windows surrounding the failure announcement is also significant, even if no significant change is detected before the event day.[19]

The results reported in Table 7 also indicate an abnormal upward revision of default probabilities for the surviving financial firms after the TARP testimony (+43.55 bps, $p < 0.05$), consistent with the intuition put forward by Taylor (2009b) and Cochrane and Zingales (2009). However, compared to Lehman's collapse, the reaction of the CDS market to the TARP speeches is somewhat weaker, not stronger, both in terms of magnitude and statistical significance.

5. Conclusion

After the spectacular failure of the 150-year old investment bank Lehman Brothers on September 15th 2008, a broad debate about the nature, triggering events, and extent of systemic risk during the recent global financial crisis has sharply divided economists and underlined the urgent need for an operational framework to analyze and assess systemic events. For many observers, the failure of Lehman was a clear example of systemic risk that materialized during the current global financial crisis. The critics generally share the view that

[19] We confirm these findings using the alternative statistical test based on the constant mean model described in this section (*unreported result*). We also repeat all the statistical tests without adjusting CDS spreads for general market conditions and find that the results, including the levels of significance, are quite similar: +98.14 bps ($p < 0.01$) for the global sample; +79.52 bps ($p < 0.01$) for the "bank" sample; +103.34 bps ($p < 0.01$) for the "non-bank" sample on day 0 and using 5-year CDS contracts.

the government decision not to rescue the troubled investment bank was a big mistake that exacerbated the adverse effects of the financial crisis. Other influential economists embraced the opposite view, arguing that it was not Lehman's failure but the uncertainty surrounding the first draft of legislation regarding the TARP released several days afterward that effectively trigger the global panic of the fall 2008. The defenders of the no-bail-out thesis contend that the government applied in the case of Lehman the right medicine at the right moment and approved its decision to deny taxpayers money to rescue the nation's fourth-largest investment bank.

The present paper contributes to the debate by focusing on two main research questions related to the systemic nature of the collapse of Lehman Brothers. First, through the use of stock market data, we examine the investors' reaction to Lehman's failure in an attempt to identify an eventual contagion effect on the surviving financial institutions. Absent a rigorous operational definition of systemic risk, it would be presumptuous to infer from an event study analysis whether Lehman was indeed "systemically important." However, a *necessary* condition for this special qualification is that the failure should have *significant* adverse knock-on effects on a large number of surviving financial institutions. Our findings indicates that the collateral damages associated to Lehman's collapse were significant at least for several categories of firms: (*i*) the largest banks and financial institutions, presumably the most exposed to the failure of the investment bank; (*ii*) the financial services firms operating in the same product area as the failed investment bank; and (*iii*) firms providing mortgages, mortgage insurance, and other related services, i.e. operating in the most shaky sector after the summer 2007 and at the core of the current financial crisis. While the collateral damages were not generalized to *all* FIs, it is worth mentioning that the *biggest* firms, which play a crucial role in the financial system, were however the most affected by the Lehman crisis. Whether

Lehman's collapse was a "systemic event" highly depends on how one defines the boundaries of the "systemic risk" concept.

Our second research question is whether the observed contagion effect affected the other surviving financial firms *indiscriminately*, that is regardless of potential differences in their risk profiles, financial conditions or physical exposures to Lehman. Overall, the results lend empirical support to the thesis that the observed contagious effects were consistent with the information-based contagion effect hypothesis. Otherwise stated, the contagion was firm-specific and discriminating rather than industry-wide or undifferentiated. The most affected financial firms were those having common characteristics with Lehman, i.e. operating in the same market, subsector or product area. More importantly, the individual abnormal stock returns are found to be strongly correlated with financial firms' fundamentals (risk profile, leverage, and profitability), suggesting that the market reaction to Lehman's failure was selective and informed, rather than random and indiscriminate.

We also detect significant abnormal jumps in the CDS spreads indicating a sudden upward revision in the market assessment of future default probabilities for the surviving financial firms, both after the Lehman failure and Ben Bernanke's and Henry Paulson's TARP speeches before the Senate Banking Committee several days later, on September 23–24, 2008. However, the reaction to Lehman's failure appears of the same order of magnitude, if not larger, than the perceived impact of the TARP testimony.

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Appendix 1: A simple market-based measure of the probability of failure

This appendix reminds the details of the basic calculations used to estimate the market-based measure of the probability of failure, expressed in percentage, for each FI in our sample. The probabilistic approach to modelling bank failures has first proposed by Blair and Heggestad (1978). See also Koehn and Santomero (1980) for additional insights.

By definition, a FI failure occurs if the losses on the portfolio of assets erode its capital base:

$$\mathrm{Prob}\{\tilde{x} < \mathrm{E}[\tilde{x}] - k\sigma_x\} \leq 1/k^2$$

where $\tilde{x}$ designates the asset earnings. Following this approach, the firm is economically insolvent and fails when asset earnings fall k standard deviations below $\mathrm{E}[\tilde{x}]$ and, as a result, the economic capital K becomes negative. The previous equation can be restated as:

$$\mathrm{Prob}\left\{\frac{\tilde{x}}{K} < \frac{\mathrm{E}[\tilde{x}] - k\sigma_x}{K}\right\} \leq 1/k^2$$

Taking into account that the failure is triggered when $\mathrm{E}[\tilde{x}] - k\sigma_x = -K$, we can re-write the probability of failure in the following way:

$$\mathrm{Prob}\left\{\frac{\mathrm{E}[\tilde{x}]}{K} < -1\right\} \leq \left(\frac{\sigma_x/K}{1 + \mathrm{E}[\tilde{x}]/K}\right)^2$$

This inequality implies that the probability of failure per unit of capital is an *increasing* function of the variance of asset earnings and a *decreasing* function of the expected value of asset earnings. From an empirical point of view, the probability of failure can thus be estimated using stock market data as the variance of equity log-returns over the estimation window divided by one plus the average equity return over the same window, squared:

$$\text{Probability of failure (\%)} = \frac{\sigma_{R_i}^2}{(1 + \bar{R}_i)^2} \times 100$$

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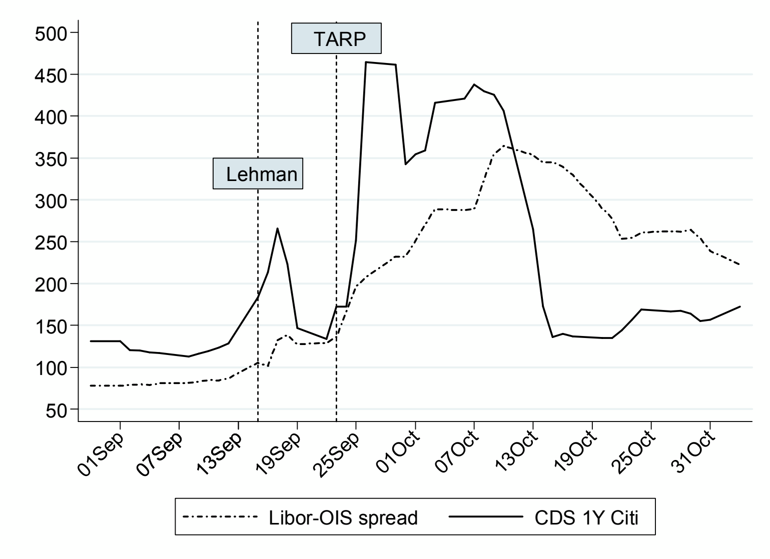
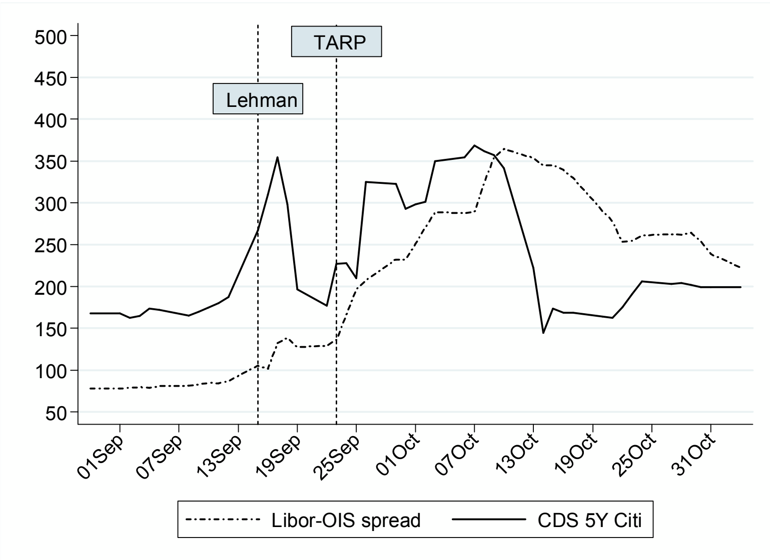
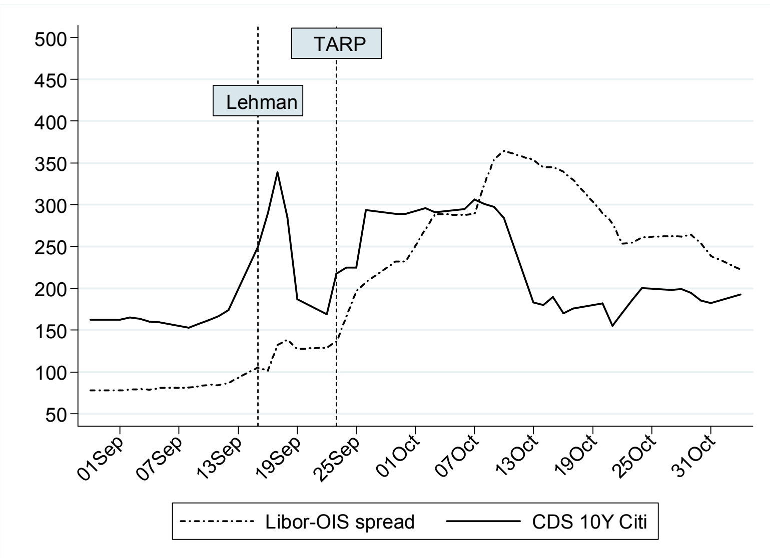
Figure 1: Libor-OIS and Citigroup CDS spread (various tenors) around Lehman's failure



a. CDS 1-year contract



b. CDS 5-year contract



c. CDS 10-year contract

Table 1: The largest US public company bankruptcy filings (1980--2009)

No.	Company name[a]	Description	Bankruptcy date	Assets[b]
1	*Lehman Brothers Holdings Inc.*	Investment Bank	09/15/2008	691,063
2	*Washington Mutual, Inc.*	Savings & Loan Holding Co.	09/26/2008	327,913
3	WorldCom, Inc.	Telecommunications	07/21/2002	103,914
4	General Motors Corporation	Manufactures & Sells Cars	06/01/2009	91,047
5	*CIT Group Inc.*	Banking Holding Company	11/01/2009	80,448
6	Enron Corp.	Energy Trading, Natural Gas	12/02/2001	65,503
7	*Conseco, Inc.*	Financial Services Holding Co.	12/17/2002	61,392
8	Chrysler LLC	Manufactures & Sells Cars	04/30/2009	39,300
9	*Thornburg Mortgage, Inc.*	Residential Mortgage Lending Co.	05/01/2009	36,521
10	Pacific Gas and Electric Company	Electricity & Natural Gas	04/06/2001	36,152
11	Texaco, Inc.	Petroleum & Petrochemicals	04/12/1987	34,940
12	*Financial Corp. of America*	Financial Services & Savings and Loans	09/09/1988	33,864
13	*Refco Inc.*	Brokerage Services	10/17/2005	33,333
14	*IndyMac Bancorp, Inc.*	Bank Holding Company	07/31/2008	32,734
15	Global Crossing, Ltd.	Global Telecommunications Carrier	01/28/2002	30,185
16	*Bank of New England Corp.*	Interstate Bank Holding Company	01/07/1991	29,773
17	*General Growth Properties, Inc.*	Real Estate Investment Company	04/16/2009	29,557
18	Lyondell Chemical Company	Global Manufacturer of Chemicals	01/06/2009	27,392
19	Calpine Corporation	Integrated Power Company	12/20/2005	27,216
20	*New Century Financial Corporation*	Real Estate Investment Trust	04/02/2007	26,147

[a] financial services firms in italic text
[b] pre-petition total assets, expressed in US$ million
Source: New Generation Research, Inc. Boston, MA

Table 2: Testing the nullity and equality of abnormal returns within the SUR framework

	Day –2	Day –1	Day 0	Day +1	Day +2
Panel A: Various sub-samples by size					
Small size (*N*=95) $\bar{\beta}_{i\tau}$	*–0.65%*	*–0.66%*	*0.76%*	*0.02%*	*2.72%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	1.80***	3.31***	3.74***	6.20***	7.38***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	1.73***	3.15***	3.55***	6.26***	7.46***
Medium size (*N*=192) $\bar{\beta}_{i\tau}$	*–1.82%*	*0.04%*	*1.83%*	*1.73%*	*1.19%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	5.39***	11.43***	7.68***	11.92***	14.33***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	5.28***	11.48***	7.06***	11.97***	14.35***
Big size (*N*=95) $\bar{\beta}_{i\tau}$	*–2.82%*	*–4.72%*	*–3.65%*	*–6.04%*	*7.34%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	3.63***	3.20***	32.30***	9.83***	6.38***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	3.63***	3.24***	32.60***	9.68***	6.07***
Big size (*N*=20) $\bar{\beta}_{i\tau}$	*–5.17%*	*–3.46%*	*–14.35%*	*–0.34%*	*–2.85%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	5.16***	2.48***	48.42***	13.87***	6.9***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	5.31***	2.57***	45.97***	14.34***	7.02***
Panel B: Various sub-samples by type of activity					
	Day –2	Day –1	Day 0	Day +1	Day +2
Mortgage & Specialty Finance (*N*=18) $\bar{\beta}_{i\tau}$	*–2.82%*	*–4.72%*	*–3.65%*	*–6.04%*	*7.34%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	1.13	3.79***	2.23***	3.70***	2.38***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	1.17	3.89***	2.17***	3.88***	2.52***
Non-bank FIs (*N*=77) $\bar{\beta}_{i\tau}$	*–2.81%*	*–1.80%*	*–4.12%*	*–1.23%*	*0.16%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	2.82***	4.26***	20.81***	6.52***	5.31***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	2.86***	4.31***	20.67***	6.53***	5.06***
Investment Services (*N*=25) $\bar{\beta}_{i\tau}$	*–4.41%*	*–1.97%*	*–10.89%*	*1.20%*	*–2.31%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	3.89***	1.65**	31.97***	9.86***	4.94***
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	3.88***	1.72**	31.02***	10.06***	5.08***
Consumer Finance (*N*=14) $\bar{\beta}_{i\tau}$	*–1.99%*	*0.96%*	*0.70%*	*–1.80%*	*–2.12%*
H_0^1: $\beta_1=\ldots=\beta_N=0$; *F*-statistic	0.60	0.54	1.50*	1.28	1.47
H_0^2: $\beta_1=\ldots=\beta_N$; *F*-statistic	0.58	0.52	1.52*	1.21	1.47

Notes: This table reports the small sample *F*-statistic for the following two hypotheses: H_0^1 $\beta_1=\ldots=\beta_N=0$ according to which the individual abnormal returns are jointly equal to zero for each day in the event window [-2; +2] and each sub-sample of financial firms; H_0^2 $\beta_1=\ldots=\beta_N$ according to which the individual abnormal returns are jointly equal to each other. The abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008) are derived from the SUR framework described in the text. The full sample of US financial firms was partitioned into various sub-samples by size (Panel A) and type of activity (Panel B).

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively

Table 3: Abnormal returns on days surrounding Lehman's collapse, US FIs -- by size

	Global sample (N=382)				Small size		Medium size		Big size (N=20)			
	Including Lehman		Excluding Lehman		(N=20)		(N=342)		Including Lehman		Excluding Lehman	
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–1.27	66.05	–1.13	65.79	–2.50*	70.00	–1.27	34.38	–2.42	42.40	0.01	38.89
–1	0.01	47.11	0.05	46.84	–1.45	85.00	0.27	21.88	–3.03	60.00	–2.38	61.11
0	–0.50	40.53	0.24	40.26	3.03**	25.00	0.39	25.52	–22.90***	75.00	–8.57***	77.77
+1	1.57	33.68	1.49	33.68	–4.14***	60.00	2.28	9.38	0.55	30.00	–0.01	33.33
+2	0.32	51.84	0.53	51.58	7.05***	10.00	–0.16	27.60	–9.86***	80.00	–6.03**	83.33
Window												
[–1; 0]	–0.48	43.81	0.29	43.55	1.58	55.00	–0.67	23.70	–25.93***	67.50	–10.96***	69.44
[0; +1]	1.08	37.11	1.73	36.97	–1.11	42.50	1.89	17.45	–22.35***	52.50	–9.88**	55.56
[0; +2]	1.40	42.02	2.26	41.84	5.93**	31.67	1.72	20.83	–32.21***	61.67	–15.91***	64.82
[–1; +1]	1.09	40.44	1.78	40.26	–2.56	56.67	1.61	18.92	–25.38***	55.00	–12.26**	57.41
[–2; +2]	0.14	47.84	1.18	47.63	1.99	50.00	0.18	23.75	–37.66***	57.00	–17.76***	58.89

Notes: This table presents the abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008), derived from the market model described in the text. The full sample of US financial firms was partitioned into three sub-samples: "Small size" (*N*=20); "Medium size" (*N*=342); and Big size (*N*=20). We also report the mean cumulative abnormal returns computed over various event windows, parametric test statistics, and percentage of negative abnormal returns.

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively

Table 4: Abnormal returns on days surrounding Lehman's collapse, US FIs -- by type of activity

	Banks and S&Ls (N=305)				Commercial Banks (N=249)				S&Ls (N=60)				Mortgage & Specialty Finance (N=18)	
	All		Top20		All		Top20		All		Top20			
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–0.87	65.90	1.86	30.00	–0.83	62.65	0.76	35.00	–0.87	76.67	–1.27	80.00	–1.99	61.11
–1	0.11	46.56	1.20	35.00	0.23	44.58	0.17	50.00	–0.62	60.00	–0.72	50.00	–5.23*	66.67
0	0.98	38.03	–5.14**	65.00	1.04	38.55	–4.64**	60.00	0.49	36.67	–2.24	45.00	–7.41**	61.11
+1	2.30*	28.85	4.25*	20.00	2.29*	29.32	2.90	20.00	1.90	28.33	4.09*	10.00	–5.05*	50.00
+2	0.87	48.52	–3.97	70.00	0.69	51.41	–5.35**	80.00	0.89	40.00	–0.47	45.00	3.57	55.56
Window														
[–1; 0]	1.09	42.30	–3.95	50.00	1.27	41.57	–4.47	55.00	–0.13	48.33	–2.96	47.50	–12.64***	63.89
[0; +1]	3.28**	33.44	–0.90	42.50	3.33*	33.94	–1.73	40.00	2.39	32.50	1.85	27.50	–12.46***	55.56
[0; +2]	4.15**	38.47	–4.86	51.67	4.01**	39.76	–7.09*	53.33	3.29*	35.00	1.37	33.33	–8.88*	55.56
[–1; +1]	3.40*	37.81	0.30	40.00	3.56*	37.48	–1.57	43.33	1.77	41.67	1.13	35.00	–17.68***	59.26
[–2; +2]	3.39	45.57	–1.81	44.00	3.41	45.30	–6.16	49.00	1.80	48.33	–0.62	46.00	–16.11**	58.89

	Non-bank FIs (N=77)				Diversified Financial Services (N=54)				Investment Services (N=25)				Consumer Finance (N=14)	
	Including Lehman		Excluding Lehman		Including Lehman		Excluding Lehman		Including Lehman		Excluding Lehman			
Day	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)	AR (%)	% (<0)
–2	–1.83	53.25	–0.88	52.00	–2.54	56.60	–1.52	55.77	–2.44	45.83	–0.14	43.48	–1.12	57.14
–1	–2.12	70.13	–1.79	69.33	–2.97*	69.81	–2.73	69.23	–1.61	70.83	–1.03	69.57	0.58	64.29
0	–7.54***	67.53	–4.06**	68.00	–9.80***	71.70	–4.58***	71.15	–15.48***	79.17	–3.94**	78.26	–2.58	64.29
+1	–0.09	45.45	–0.87	46.67	–0.45	43.40	–1.11	44.23	1.79	45.83	0.38	47.83	–0.78	64.29
+2	–3.27*	74.03	–2.19	73.33	–2.49	69.81	–1.02	69.23	–5.98***	66.67	–2.81*	65.22	–5.42**	92.86
Window														
[–1; 0]	–9.66***	68.83	–5.85**	68.67	–12.77***	70.75	–7.32***	70.19	–17.09***	75.00	–4.97*	73.91	–2.01	64.29
[0; +1]	–7.63***	56.49	–4.93**	57.33	–10.25***	57.55	–5.70**	57.69	–13.69***	62.50	–3.55	63.04	–3.36	64.29
[0; +2]	–10.90***	62.34	–7.12**	62.67	–12.74***	61.64	–6.71**	61.54	–19.68***	63.89	–6.36**	63.77	–8.78**	73.81
[–1; +1]	–9.75***	61.04	–6.72**	61.33	–13.21***	61.64	–8.43***	61.54	–15.38***	65.28	–4.58	65.22	–2.78	64.29
[–2; +2]	–14.85***	62.08	–9.79***	61.87	–18.24***	62.26	–10.97***	61.92	–23.72***	61.67	–7.53**	60.87	–9.32*	68.57

Notes: This table presents the abnormal returns for a five-day period surrounding the failure announcement date (day 0 = September 15th, 2008), derived from the market model described in the text. The full sample of US financial firms was partitioned into various sub-samples with respect to the type of activity. We also report the mean cumulative abnormal returns computed over various event windows, parametric test statistics, and percentage of negative abnormal returns.

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively

Table 5: Bivariate comparisons of risk, profitability, and leverage measures across various sub-samples

Variable	Global			Small size			Big size			Small vs. Big			Banks			Non-banks			Banks vs. Non-banks		
	N	Mean	Med.	N	Mean	Med.	N	Mean	Med.	*t*-stat[a]	Chi2[b]	*z*-stat[c]	N	Mean	Med.	N	Mean	Med.	*t*-stat[a]	Chi2[b]	*z*-stat[c]
Risk measures																					
Loan loss res/Tot loans	329	1.62	1.28	84	1.25	1.16	79	1.55	1.33	–2.05**	5.89**	–1.79*	302	1.40	1.28	27	4.06	0.88	–1.90*	0.34	0.92
Loan loss prov/Tot loans	324	0.48	0.20	84	0.26	0.14	76	0.59	0.35	–3.64***	16.94***	–4.36***	303	0.36	0.20	21	2.24	0.88	–2.26**	4.12**	–3.41***
Non-perf assets/Tot assets	317	1.71	0.97	83	1.62	0.98	72	1.56	0.96	0.18	0.32	0.75	299	1.66	0.97	18	2.63	0.63	–0.77	0.22	0.41
Credit ratings	110	8.65	8.00	31	9.35	9.00	79	8.37	7.00	–1.28*	8.88***	–3.07***	66	7.83	8.00	44	9.86	9.00	–2.23**	2.22	–1.64*
Probability of failure	381	0.19	0.12	95	0.18	0.12	94	0.20	0.12	–0.62	0.01	–0.72	305	0.16	0.11	76	0.29	0.15	–4.26***	8.86***	–2.98***
Leverage																					
Tot debt/Tot assets	380	23.75	18.36	95	17.27	16.68	94	31.14	24.36	–5.15***	12.70***	–4.40***	304	18.85	17.37	76	43.33	39.78	–6.40***	11.12***	–5.22***
LT debt/Total assets	380	14.52	11.19	95	11.87	10.76	94	16.67	12.62	–2.40***	2.33	–1.24	304	11.90	11.08	76	24.97	13.17	–4.07***	0.59	–2.34**
ST borr/ Total assets	364	9.57	6.12	92	5.57	3.79	92	14.43	10.67	–5.22***	28.17***	–5.47***	294	7.08	5.78	70	20.06	9.25	–4.59***	1.77	–2.00**
Comm eq/Total assets	380	12.35	9.09	95	12.65	8.90	94	12.53	9.21	0.06	0.89	0.57	304	9.50	8.89	76	23.77	16.77	–4.78***	7.96***	–4.11***
Risk-based capital	300	13.15	11.70	79	13.55	11.56	72	14.33	12.28	–0.52	1.91	–1.96**	288	12.79	11.67	12	21.91	14.19	–1.16	5.56**	–2.48**
Profitability																					
Return on equity	370	2.59	7.45	95	5.17	7.10	91	2.43	7.20	0.99	0.19	0.44	301	4.01	7.47	69	–3.61	7.10	1.73*	0.02	0.77
Return on assets	377	0.17	0.68	95	0.25	0.72	92	0.42	0.69	–0.24	0.05	0.11	302	0.37	0.70	75	–0.63	0.50	0.74	0.77	0.19
Efficiency ratio	362	66.35	63.32	91	67.19	66.33	91	63.88	58.85	0.74	11.63***	2.91***	303	63.73	62.89	59	79.75	67.00	–1.88*	1.64	–0.91
Net income/Total assets	379	–0.16	0.15	95	–0.09	0.14	93	0.02	0.15	–0.47	0.19	0.07	303	–0.03	0.14	76	–0.66	0.16	1.21	1.11	–1.31
Other control variables																					
Total assets(†)	379	46.00	3.05	95	1.34	1.29	93	180.00	22.44	–4.39***	184.04***	–11.84***	303	34.33	2.75	76	92.51	6.04	–1.89*	8.11***	–3.61***
Total market value(†)	379	45.17	3.06	95	1.37	1.26	93	170.00	25.92	–4.46***	184.04***	–11.84***	303	33.01	2.82	76	93.64	6.08	–2.00**	11.30***	–3.96***
Price-to-book ratio	371	3.26	0.96	92	1.25	0.93	93	1.47	1.00	–0.69	1.22	–0.28	300	1.04	0.95	71	12.67	1.21	–1.17	3.03*	–2.67***
Net loans/Tot assets	347	66.80	71.57	89	69.94	73.44	87	59.31	67.61	3.29***	6.57***	3.91***	303	70.60	72.21	44	40.63	30.58	6.11***	12.45***	5.20***
Mkt securities/Tot assets	379	18.13	14.26	95	17.19	14.62	93	22.37	15.93	–1.98**	1.04	–1.48	303	15.82	14.33	76	27.34	11.79	–3.31***	0.05	0.16

Notes: This table presents several key financial variables measuring three dimensions of the banking performance (risk, operating leverage, and profitability), as well as other control variables (mean and median values) calculated separately for the full sample and various sub-samples of banks ("Small" vs. "Big" size; "Banks" vs. "Non-bank" FIs). See text for the definition of variables.

(a) *t*-test on the equality of means; (b) nonparametric two-sample test on the equality of medians; (c) Wilcoxon-Mann-Whitney rank-sum test for the hypothesis that the two independent sub-samples (i.e., unmatched data) are from populations with the same distribution

(†) x10^3

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively

Table 6: Correlation coefficients between abnormal returns and proxies for risk and performance

Variable	Global sample			Banks subsample			Non-banks subsample		
	N	SAR0	SCAR[0;+1]	N	SAR0	SCAR[0;+1]	N	SAR0	SCAR[0;+1]
Risk measures									
Loan loss reserves/Total loans	329	–0.116**	–0.153***	302	–0.187***	–0.184***	27	0.064	–0.044
Loan loss provisions/Total loans	324	–0.126**	–0.211***	303	–0.117**	–0.162***	21	0.101	–0.102
Non-performing assets/Tot assets	317	–0.070	–0.191***	299	–0.100*	–0.249***	18	0.218	0.116
Credit ratings	110	–0.350***	–0.430***	66	0.051	–0.028	44	–0.414***	–0.450***
Probability of failure	380	–0.176***	–0.244***	304	–0.168***	–0.241***	76	–0.216*	–0.316***
"Largest exposures" dummy	380	–0.214***	–0.148***		--	--		--	--
Leverage									
Total debt/Total assets	380	–0.299***	–0.352***	304	–0.252***	–0.120**	76	–0.200*	–0.299***
Long-term debt/Total assets	380	–0.130**	–0.194***	304	–0.157***	–0.122**	76	–0.020	–0.096
Short-term borr/Total assets	366	–0.311***	–0.323***	295	–0.237***	–0.075	71	–0.249**	–0.308***
Common equity/Total assets	380	0.007	0.047	304	0.124**	0.196***	76	0.130	0.219*
Risk-based capital ratio		--	--	298	0.283***	0.167***		--	--
Profitability									
Return on equity	370	0.073	0.151***	301	0.093*	0.233***	69	0.018	0.044
Return on assets	377	0.069	0.116**	302	0.132**	0.232***	75	0.045	0.084
Efficiency ratio	362	–0.435***	–0.381***	303	–0.065	–0.183***	59	–0.498***	–0.411***
Net income/Total assets	379	0.053	0.106**	303	0.064	0.126**	76	0.018	0.064
Other control variables									
Total assets	379	–0.315***	–0.266***	303	–0.406***	–0.199***	76	–0.301***	–0.338***
Total market value	379	–0.318***	–0.270***	303	–0.405***	–0.197***	76	–0.298***	–0.336***
"Non-banks" dummy	382	–0.245***	–0.298***		--	--		--	--
Price-to-book ratio	371	0.043	0.010	300	0.279***	0.344***	71	0.082	0.054
Tobin q	375	–0.012	–0.038	301	0.184***	0.227***	74	0.090	0.086
Net loans/Tot assets	347	0.241***	0.243***	303	–0.008	–0.054	44	0.173	0.170
Market securities/Total assets	379	–0.227***	–0.199***	303	0.093*	0.114**	76	–0.257**	–0.235**

Notes: This table presents correlation coefficients between standardized abnormal returns on day 0 (SAR0) and standardized cumulative abnormal returns over the event window [0;+1] (SCAR[0;+1]), on the one side, and several key financial variables measuring three dimensions of the banking performance (risk, operating leverage, and profitability) and other control variables, on the other side. The correlation coefficients are computed for the global sample, as well as for two sub-samples: "Banks" and "Non-bank" FIs. See text for the definition of variables.

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively

Table 7: Adjusted CDS spread changes (in bps) around Lehman's failure and TARP testimony

Panel A: Senior 1-year Credit Default Swap (CDS) contracts						
	Lehman's failure (Day 0 = September 15th, 2008)			*TARP testimony (Day 0 = September 23rd, 2008)*		
Day	All FIs (N=85)	Banks (N=18)	Non-bank FIs (N=67)	All FIs (N=85)	Banks (N=18)	Non-bank FIs (N=67)
–1	7.55	3.81	8.63	–26.94**	–27.96***	–26.65**
	(65.88%)	(77.77%)	(62.68%)	(32.94%)	(5.55%)	(40.29%)
0	60.50***	79.71***	54.96***	39.01**	91.12***	24.01
	(72.94%)	(88.88%)	(68.65%)	(70.58%)	(100.00%)	(62.68%)
+1	72.82***	79.36***	70.94***	19.31	39.67***	13.45
	(75.29%)	(88.88%)	(71.64%)	(68.23%)	(72.22%)	(67.16%)
Window						
[–1; 0]	68.05***	83.52***	63.60**	–0.82	50.26**	–15.53
	(69.41%)	(83.33%)	(65.67%)	(51.76%)	(52.77%)	(51.49%)
[0; +1]	133.33***	159.07***	125.91***	58.33**	130.80***	37.47
	(74.11%)	(88.88%)	(70.14%)	(69.41%)	(86.11%)	(64.92%)
[0; +2]	136.41***	220.15***	112.30***	84.68***	194.53***	53.06*
	(69.80%)	(85.18%)	(65.67%)	(67.05%)	(79.62%)	(63.68%)
[–1; +1]	140.88***	162.88***	134.55***	18.49	89.94***	–2.07
	(71.37%)	(85.18%)	(67.66%)	(57.25%)	(59.25%)	(56.71%)
[–2; +2]	162.71***	235.00***	141.89***	–4.71	106.13***	–36.62
	(69.41%)	(83.33%)	(65.67%)	(53.88%)	(51.11%)	(54.62%)
Panel B: Senior 5-year Credit Default Swap (CDS) contracts						
	Lehman's failure (Day 0 = September 15th, 2008)			*TARP testimony (Day 0 = September 23rd, 2008)*		
Day	All FIs (N=85)	Banks (N=18)	Non-bank FIs (N=67)	All FIs (N=85)	Banks (N=18)	Non-bank FIs (N=67)
–1	3.58	2.18	3.96	–10.54	8.31	–15.53
	(69.31%)	(73.68%)	(68.11%)	(40.90%)	(26.31%)	(44.92%)
0	87.58***	72.24***	91.64***	43.55**	64.17***	38.09*
	(73.86%)	(84.21%)	(71.01%)	(71.59%)	(89.47%)	(66.66%)
+1	87.03***	53.66***	95.87***	52.18***	36.21***	56.40**
	(73.86%)	(73.68%)	(73.91%)	(60.22%)	(63.15%)	(59.42%)
Window						
[–1; 0]	91.17***	74.42***	95.60***	22.47	61.95***	12.01
	(71.59%)	(78.94%)	(69.56%)	(56.25%)	(57.89%)	(55.79%)
[0; +1]	174.61***	125.90***	187.51***	95.73***	100.38***	94.50***
	(73.86%)	(78.94%)	(72.46%)	(65.90%)	(76.31%)	(63.04%)
[0; +2]	142.77***	174.31***	134.43***	121.94***	163.81***	110.86***
	(67.42%)	(75.43%)	(65.21%)	(62.87%)	(66.66%)	(61.83%)
[–1; +1]	178.20***	128.08***	191.47***	74.65**	98.16***	68.42*
	(72.34%)	(77.19%)	(71.01%)	(57.57%)	(59.64%)	(57.00%)
[–2; +2]	157.49***	186.70***	149.76***	51.95	84.76***	43.26
	(68.40%)	(74.73%)	(66.66%)	(52.95%)	(46.31%)	(54.78%)

Notes: These table show average changes in adjusted CDS spreads (expressed in basis points) on various periods around Lehman's bankruptcy date (day 0 = September 15th, 2008) and on several days surrounding Ben Bernanke's and Henry Paulson's TARP speeches before the Senate Banking Committee (day 0 = September 23rd, 2008). The full sample of US financial obligors (*N*=85) was partitioned into two sub-samples: "Banks" (*N*=18) and "Non-bank FIs" (*N*=67). We also report the mean cumulative change computed over various event windows, parametric test statistics, and percentage of positive abnormal adjusted CDS spread changes (in parentheses). The results are reported separately for the 1-year CDS contracts (Panel A) and 5-year CDS contracts (Panel B). Significance levels for adjusted CDS spread changes are determined with reference to the standard deviation of adjusted changes estimated over a 250-day estimation window.

***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively